MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

SUPPLEMENTARY EXAMINATION

TRIMESTER 1, 2015/2016

EEL2186 – CIRCUITS AND SIGNALS

(All sections / Groups)

18 NOV 2015
2.30 PM – 4.30 PM
(2 HOURS)

INSTRUCTION TO STUDENTS

1. This Question paper consists of 8 pages including cover page with 5 Questions only.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. A table of Laplace Transform properties is attached in Appendix A for your reference.

Question 1

a) A bridge circuit is as shown in Figure Q1a.

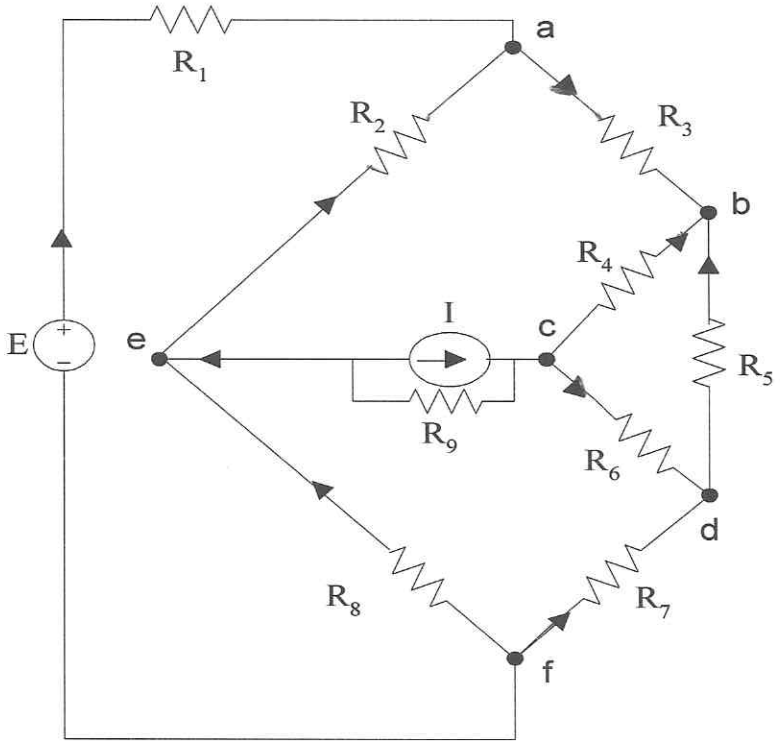

Figure Q1a

i) Sketch an **oriented tree** and its corresponding **co-tree** for the bridge circuit in a single diagram. Label all the nodes and the branches clearly. Use the tree branch selection and numbering sequence guidelines to sketch and label your tree.

[3 marks]

ii) Obtain the fundamental cutsets based on the tree you have drawn in part (a)(i) above. Write out the current equations from the f-cutsets.

[5 marks]

iii) It is given that the currents through the branches with resistors R_2, R_4, R_5 and R_6 are 2A, 5A 7A and 10A, respectively. Solve for the **remaining branch currents**. [6 marks]

Continued...

b) Given the following mesh incidence matrix, B. The rows (*I*, *II* and *III*) denote the meshes while the columns (1, 2, 3, 4, 5 and 6) denote the branches. Based on the matrix B, draw an **oriented graph**. Label the nodes, branches, meshes and also indicate the direction assumed for each mesh clearly.

$$\mathrm{B} = \begin{array}{c} \\ I \\ II \\ III \end{array} \begin{array}{c} \begin{array}{cccccc} 1 & 2 & 3 & 4 & 5 & 6 \end{array} \\ \begin{bmatrix} 1 & -1 & 0 & -1 & 0 & 0 \\ -1 & 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 \end{bmatrix} \end{array}$$

[3 marks]

Continued...

Question 2

a) Evaluate the following integrals:

i) $\int_{-\infty}^{\infty}(t-1)^3\delta(-2t+1)dt$ [3 marks]

ii) $\int_{-\infty}^{\infty}(\sin t)\,\delta\left(t-\frac{\pi}{2}\right)dt$ [2 marks]

b) Sketch the following pulse function:

$$f(t)=\frac{1}{3}P_4(t-5)$$

[2 marks]

c) The unit impulse response of a linear time invariant (LTI) continuous time system is given as:

$$h(t)=(t-2)^2\,u(t)$$

Determine the system output, *y(t)*, if the input is $x(t) = u(t+5)$.

[5 marks]

d) Decompose the following signal into its even and odd components:

$$f(t)=\frac{1}{2}t+3t^2+4t^3-6t^4$$

[4 marks]

Continued...

Question 3

a) State the dependent and independent variables of the equations for the following two-port network parameters:
   i) *y*-parameters [2 marks]
   ii) *h*-parameters [2 marks]

b) Derive the *z*-parameters equations in terms of *y*-parameters. [3 marks]

c) Refer to the reciprocal two-port network shown in Figure Q3c.
   i) Calculate the *z*-parameters of the network. [4 marks]
   ii) Is the network symmetrical? Justify your answer. [2 marks]

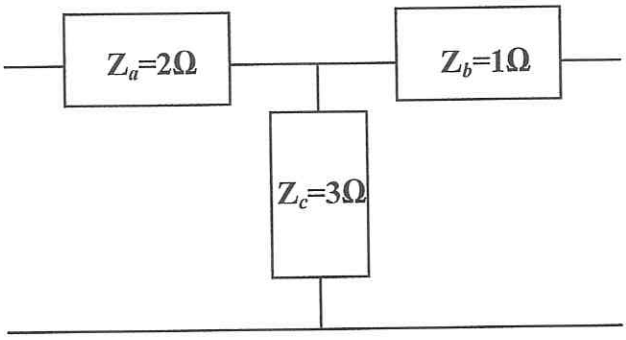

Figure Q3c

d) Figure Q3d presents two-port networks N_a and N_b connected in series. Using similar format, sketch the following networks:
   i) Networks N_a and N_b connected in parallel. [2 marks]
   ii) Networks N_a and N_b connected in cascade. [2 marks]

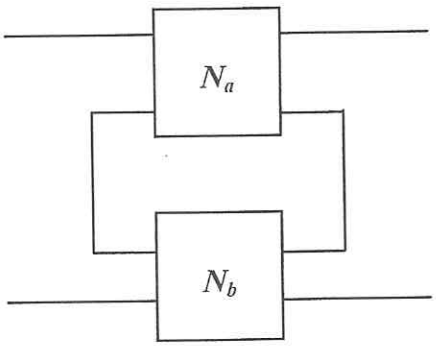

Figure Q3d

Continued...

Question 4

a) The unit step response of a particular system with overall transfer function, $H(s)$ starting from zero initial conditions, is given as,

$$y(t) = 10 - 4e^{-2t} - 6e^{-3t}$$

i) Perform Laplace transform on $y(t)$ using the table given in Appendix A. Simplify the answer to a single numerator polynomial and a single denominator polynomial. [5 marks]

ii) Find the transfer function, $H(s)$ of the system. [3 marks]

iii) Obtain the unit impulse response of the system. [5 marks]

b) A circuit has a state equation $\dot{\mathbf{x}} = \begin{bmatrix} -1 & 4 \\ -1 & -2 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 3 \\ 0 \end{bmatrix}\mathbf{z}$ and an output equation $\mathbf{y} = \begin{bmatrix} 4 & -2 \end{bmatrix}\mathbf{x}$, where $\mathbf{x}$ is the state vector, $\mathbf{z}$ is the input vector, and $\mathbf{y}$ is the output vector. $\dot{\mathbf{x}}$ is the first derivative of the state vector with respect to time.

i) Find the transfer function of the circuit. [7 marks]

ii) Calculate the eigenvalues of the circuit. [3 marks]

iii) Is the circuit stable? Justify your answer. [2 marks]

Continued...

Question 5

a) Synthesize the network given by the function $Z(s)=\frac{s(s^2+5)}{s^2+3}$ using:

i) Foster 1st method [7 marks]
ii) Cauer 1st method [6 marks]

(Note: Final network must be drawn and labeled)

b) A given Butterworth filter has the following specifications:

Maximum pass-band attenuation, A_p = 3 dB
Minimum stop-band attenuation, A_s = 50 dB
Maximum pass-band frequency, f_p = 5 kHz
Minimum stop-band frequency, f_s = 15 kHz

Determine the

i) order of the filter, n [6 marks]
ii) constant, ε, which satisfies the stop-band [2 marks]
iii) cut-off frequency, f_c, which is satisfied for the pass-band [4 marks]

End of paper.

Appendix A: Table of Laplace Transform Properties.

No.	*t*-domain function	*s*-domain transform
1.	$\delta(t)$	1
2.	$u(t)$	$1/s$
3.	$tu(t)$	$1/s^2$
4.	t^n	$\frac{n!}{s^{n+1}}$
5.	e^{-kt}	$\frac{1}{s+k}$
6.	$t^n e^{-kt}$	$\frac{n!}{(s+k)^{n+1}}$
7.	$\sin\omega t$	$\frac{\omega}{s^2+\omega^2}$
8.	$\cos\omega t$	$\frac{s}{s^2+\omega^2}$
9.	$e^{-kt}\sin\omega t$	$\frac{\omega}{(s+k)^2+\omega^2}$
10.	$e^{-kt}\cos\omega t$	$\frac{s+k}{(s+k)^2+\omega^2}$
11.	$t\sin\omega t$	$\frac{2\omega s}{(s^2+\omega^2)^2}$
12.	$\sinh\beta t$	$\frac{\beta}{s^2-\beta^2}$
13.	$\cosh\beta t$	$\frac{s}{s^2-\beta^2}$
14.	$\sin(\omega t+\phi)$	$\frac{s\sin\phi+\omega\cos\phi}{s^2+\omega^2}$
15.	$2\lvert k\rvert e^{-\sigma t}\cos(\omega t-\varphi)$, where $k=\lvert k\rvert\angle\varphi$	$\frac{k}{s+\sigma+j\omega}+\frac{k^*}{s+\sigma-j\omega}$
16.	$f(t)$ periodic with period T	$\frac{1}{1-e^{-Ts}}\int_0^T f(t)e^{-st}dt$